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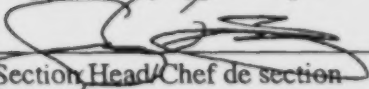
DEVELOPMENT OF A TOPOGRAPHICAL
MAP DISPLAY
(ToMaDi)

by

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December/décembre 2001

Approved by/approuvé par


Section Head/Chef de section

28 nov 01

Date

SANS CLASSIFICATION

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ABSTRACT

This technical memorandum describes in detail the development of a Topographical Map Display (ToMaDi). The ToMaDi display is an evaluation prototype, made from a 2 by 2 matrix of colour AC Plasma Display Panel (PDP) and designed to study alternatives to topographical paper maps for Command and Control (C&C) applications. Because ToMaDi is a computer display, it contributes to the digitization of the battlefield project. The brightness, the contrast ratio and the viewing angle are similar to that of a Cathode Ray Tube (CRT) display. But, contrarily to CRT, its shallow depth allows its usage in confined locations while maintaining a high portability. Despite the fact that their visual characteristics don't meet the quality of a paper topographical map, the results obtained are sufficiently positive to warrant both follow-up studies in advanced display systems and ToMaDi applications for the Department of National Defence.

RÉSUMÉ

Ce mémorandum technique décrit de façon détaillée la réalisation d'un système d'affichage électronique pour cartes topographiques (AfCaTo). Celui-ci est un prototype d'évaluation, constitué d'une mosaïque de quatre écrans couleurs au plasma à courant alternatif. Il a été conçu pour étudier une alternative à l'utilisation des cartes topographiques en papier pour les applications de commandement et contrôle (C&C). Parce qu'il est un affichage d'ordinateur, il contribue au projet de numérisation du champ de bataille. Sa brillance, son contraste et son angle de vision sont semblables à ceux des affichages à Tubes à Écran Cathodique (TEC). Cependant, contrairement aux TEC, sa faible profondeur lui permet d'être facilement transportable et de l'utiliser dans les endroits exigües. En dépit du fait que l'AfCaTo a des caractéristiques visuelles inférieures à celles des cartes topographiques en papier, les résultats obtenus sont suffisamment positifs pour justifier à la fois des études plus approfondies des systèmes d'affichage avancés et des études d'applications de l'AfCaTo au sein du ministère de la Défense nationale.

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EXECUTIVE SUMMARY

The recent progress in the computer science domain allowed the development of tactical information processing systems which are very powerful, dependable and relatively cheap. The Canadian Forces (CF) have been developed information processing systems to increase the efficiency of sea, land, air and joint operational centers for their Command and Control (C&C) tasks. Unfortunately, despite the usage of powerful computer systems, the military staff still rely heavily on the use of paper maps and milar traces on which they annotate the operational/tactical situation. Moreover, because of the operations spatial extent or the displacement of a localized tactical operation in time, many map sheets are needed and require much space in a command post. To resolve these problems of map marking and paper map manipulation in an exiguous space, the usage of large electronic high resolution Flat Panel Display (FPD) would be the solution. Such kind of display would have the following advantages: render the C&C Information System (CCIS) digital from end to end; allow the visualization of many maps in exiguous locations; allow the visualization of the same tactical information along the chain of command.

Defence Research Establishment Valcartier (DREV) has undertaken several projects to design and develop new C&C decision aids. One of them is the Advanced Capability Tactical Information Fusion (ACTIF). This project involves the development of data processing system based on a network of PC workstations and a SUN server linked together with an Ethernet link. The Topographical Map Display (ToMaDi) is one of the component of this system and it meant to highlight the benefit of large and flat panel display technology in a command post.

This memorandum describes the development of the ToMaDi display which is constituted of a display unit made from a mosaic of four plasma FPD linked with a PC workstation used as an X terminal. The global setup, designed and realized in many parts by the author with cheap off-the-shelf components, should be considered as an evaluation prototype since it is not the final solution of all of the above problems. However, the work done for this project is the first step of a global process which may lead to the production a fieldable integrated decision aid console.

This work is directly relevant to the CF requirements, and it is applicable to present and future CCIS.

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LIST OF ACRONYMS

AC	Alternating Current
ACTIF	Advanced Concept for Tactical Information Fusion
A/D	Analog-to-Digital
B/W	Black and White
CCIS	C&C Information System
CF	Canadian Forces
CFM	Cubic Feet per Minute
CIE	Commission Internationale de l'Éclairage
COTS	Commercial of the Shelf
CRT	Cathode Ray Tube
C&C	Command and Control
DC	Direct Current
ELD	Electroluminescent Display
FED	Field Emission Display
FPD	Flat Panel Display
IR	Infrared
LCD	Liquid Crystal Display
NTSC	National Television Standard Committee
OSM	On Screen Menu
PDP	Plasma Display Panel
PLL	Phase Locked Loop
ppi	pixels per inch
TEC	Tube à Écran Cathodique
ToMaDi	Topographical Map Display
VFD	Vacuum Fluorescent Display
VGA	Video Graphics Array
XGA	eXtended Graphics Array

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1.0 INTRODUCTION

In an operation center, or a command post, maps are the main element to depict the global situation. Nowadays, the topographical maps are used intensively and they are able to indicate the global situation down the small terrain attributes. Since the last forty years, electronic displays, particularly Cathode Ray Tube (CRT), have gain in popularity, but their limited size and visual characteristics has prevented this technology to meet all the military requirements in term of map display. That's for those reasons that topographical maps are difficult to supersede (Ref. 1). Despite the widespread use of electronic displays, CRTs in particular, topographical paper maps are still largely used. The electronic displays have significant limitations in term of their size and their visual characteristics, which prevent them to totally supersede paper maps.

However, since the last twenty years, the advanced panel display devices like Liquid Crystal Display (LCD), Plasma Display Panel (PDP), Vacuum Fluorescent Display (VFD), Field Emission Display (FED) and Electroluminescent Display (ELD), to name a few, have made so much progress that they now offer a good alternative to topographical paper maps (Ref. 2). These display technologies provide flat panels and exhibit good visual characteristics. The main limitation is still the total size of the display viewing area. A solution to increase the display size is to create a mosaic of flat panel displays. This is the object of the Topographical Map Display (ToMaDi) project. Four PDP panels made by Fujitsu were put in a 2 x 2 configuration to reach a global size of 42" in diagonal which is sufficient to display the majority of 1:50k topographical maps. The "tiling" approach, which has many advantages, was used because no Flat Panel Display (FPD) of that size (with a satisfactory resolution) was available at the beginning of the project.

Section 2 describes what would be an ideal topographical display. In Section 3, all the aspects related to the ToMaDi hardware implementation are presented, particularly the Fujitsu FPF21C8060UA PDP which is the ToMaDi's main component. In Section 4, the ToMaDi's performances are highlighted in terms of visual quality and electrical characteristics. In the last section, based on the ToMaDi's weaknesses, suggestions for improvement are examined and lay out the path to future work in this domain.

This work was performed at DREV under unit 2kg17, Test and Evaluation Support for CCIS, between February 1997 and October 1998.

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2.0 MAP DISPLAY CRITERIA

Topographical maps used in command posts are generally of great dimension and contain detailed terrain information. Some of them are monochrome but the majority of the maps use a variety of shades of colours, such as green, light green, brown, red, light red, blue, light blue and black. In consequence, an FPD used to display such maps should have a colour capacity of at least 8 bits per pixel. If different kinds of symbols have to be layered on the map or any kind of graphical information has to be displayed (B/W and colour photography, video sequences, etc.), 16 or 24 bit per pixel would be much better.

In military operations at the tactical level, the mostly used topographical maps have a scale of 1 to 50k (1:50k). At this ratio, the largest paper map sheets have a size of 30" x 22". For this reason, an FPD used to display any kind of 1:50k map should have an effective visual display size bigger than 30" x 22".

The last factor but not the least, a topographical map contains a great deal of small details like fine lines, little symbols (i.e.: swamp). This characteristic is very important since military peoples who work with maps want absolutely to see the same thing either on a FPD or a map. To illustrate the effect of the local resolution, expressed usually in pixels per inch (ppi), a portion of a digitized 1:50k topographical map of CFB Valcartier is shown at 5 different resolutions at Appendix A. The map was originally scanned at 300ppi. Clearly, the ones displayed at 150 and 100ppi are sufficiently resolved to be displayed on an FPD. At 75ppi and below the fine details become unrecognizable and therefore unusable. In consequence, the local resolution of the chosen display would be as high as possible but should not be less than 80ppi.

3.0 ToMaDi DESCRIPTION

The ToMaDi system is principally constituted with a display unit made from a mosaic of four PDP, and a PC workstation using dedicated video interfaces. The complete setup is illustrated in Fig. 1.

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3.1 Basic Architecture

ToMaDi's basic architecture is illustrated in Fig. 2. In the Display Unit, there are four PDPs, Analog to Digital (A/D) interfaces and DC/DC converters. The four PDPs named A to D are located respectively in the upper left, upper right, lower left and lower right corners of the display unit. The DC/DC converters are used to produce the +5 and +12V needed by the A/D interfaces, with the +5V from the power supply A to D. The principal mechanical drawings of the display unit, including those for the supports and the control unit are shown in Appendix B.

3.2 Display Unit and Power Supply

The PDP used to build the display unit is the FPF21C8060UA-02 made by the Fujitsu company. The image of this PDP is illustrated in Fig. 3 and all the mechanical and electrical characteristics are shown in Appendix C.

This PDP unit has been chosen among many other FPDs available on the market in the first quarter of 1997. The basic characteristics of those FPDs are listed in the Table I. Based on the map size criteria (30" x 22"), only the Mitsubishi 40" and the Fujitsu 42" were compliant, but their local resolution of 20 and 23.5ppi, respectively, were too low to display correctly digitized maps. Only the Mitsubishi 13" and the IBM 16" met the local resolution criteria (>100ppi), but their size of 13" and 16", respectively, implied the realization of a 3 x 3 mosaic which was too expensive for the project¹. Between these two extremes, to get a sufficiently sized display at moderate cost, the FPF21C8060UA PDP from Fujitsu was chosen. By using four of them in a 2 x 2 configuration, the obtained display has a diagonal size of 42" (34" x 25") for a price of 40k\$CND. The photography of a tactical map displayed by ToMaDi is illustrated at the Fig. 4.

The basic characteristics of the chosen PDP are the following:

Total resolution:	640 x 480 (VGA)
Number of colours:	262144 (18 bit)

1. The price of those units at that time (Q1 97) was approximately 12k\$CND each.

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Weight:	4.8kg
Thickness:	35mm
Interface:	digital VGA
Power consumption:	~150W

To energize appropriately each PDP, the manufacturer suggests the FPF09P-AC100 power supply. It produces the +5 and the +200V to the PDP and guarantees to produce the appropriate power-up and power-down sequences to avoid display malfunction. All the four power supplies have been grouped together to form the power supply unit.

Since the total power consumption of all PDPs in the display unit reaches almost 600W, special care was put on ventilation. Eight fans, of ~20 Cubic Feet per Minute (CFM) each, have been located behind the four PDPs to avoid heat buildup.

On the front of the display unit, a plastic anti-reflection sheet was used to protect the four PDPs and minimize specular reflections of the surrounding lights on the display window. Combined with the black anodized front plate, they contribute to keep a high contrast ratio.

3.2.1 PDP Principle

In order to help the comprehension of the PDP principle, the cross section of one colour cell is illustrated in Fig. 5. The plasma panel itself is a structure made from a pair of parallel plates of glass filled with a neon/xenon gas mixture. Transparent (Indium Tin Oxide) display electrode pairs are located on the top plate. When a sufficiently high voltage (~100V) is applied between the electrodes, a surface-discharge is generated on the MgO layer and produces ultraviolet (UV) light. The phosphor on the bottom of the discharge cell is excited by the UV light and produces a visible light (red, green or blue) by phosphorescence through the front glass plate. Since there are 3 prime colour cells per pixel, it's possible to produce the full colour gamut by modulating the luminance of each one. Since each pixel emit its own light, the PDP is emissive. This characteristic lead to a wide viewing angle, contrarily to transmissive displays like Liquid Crystal Display (LCD).

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3.3 Workstation and Interfaces

The heart of the ToMaDi system is the DELL Optiplex GX Pro workstation. Their characteristics are listed in Table. II. With the software "Xoftware" and its Ethernet interface, it's able to emulate an X terminal.

One of a new C&C decision aid designed and developed at Defence Research Establishment Valcartier (DREV) is the Advanced Capability Tactical Information Fusion (ACTIF) (Ref. 3, 4). This project involves the development of data processing system based on a network of PC workstations and a SUN server linked together with an Ethernet link. As an X terminal, the ToMaDi can be a component of this system and it meant to highlight the benefit of large and flat panel display technology in a command post.

Since the PC has to drive four PDPs, special video adapters had to be used. It was also decided to add a real-time video display capability to ToMaDi's features. Do do so, the video adapter "Twin Tuna", made by the Colorgraphic company, was chosen. It has to drive the two upper PDP while displaying two RS-170/NTSC signals in distinct windows. This feature allows to see video information from visible or Infrared (IR) imager signal on the ToMaDi display unit. To drive the two lower remaining PDPs, the video adapter "Evolution 2" made by the same company was used. Both of them are PCI interfaces.

The four analog video signals (VGA) produced by the video adapters, having each a 640 pixels x 480 pixels resolution, cannot be used directly by the four PDPs. Each VGA signal has to be digitized via an A/D converter before entering the PDP which is a digital device. In the display unit, this job is done by the M2 full-colour analog video to flat panel interface board made by Pixelvision. In addition to the A/D function, it allows the user changing, via the On Screen Menu (OSM)², the characteristics of the image displayed (brightness, contrast, image position, image size, etc.). All the lines dedicated to control the OSM were grouped together and sent to the control unit.

By its effective display size of 42" in diagonal, the display unit is intended to be used on a wall to broadcast the visual information to the surrounding people. To facilitate the operator's job, a video selector and an auxiliary display were added.

2. Displayed in the corresponding PDP.

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4.0 ToMaDi's CHARACTERISTICS

The characteristics of the ToMaDi system are the following:

Display technology used: AC Plasma

Total resolution: 1280 x 960 pixel

Effective display size: 33" x 25" (42" diagonal)

Aspect ratio: 4:3

Local resolution: 38.5ppi

Brightness: 120cd/m² (CRT~150cd/m²)

Contrast ratio: 60:1 (CRT~100)

Viewing angle: 140° (horizontal & vertical)

Visual Fill Factor: 88%

Weight: ~70kg

External dimension: 65" (w) x 43" (h) x 6" (d)

Power consumption: ~1000W

In addition to those characteristics, ToMaDi can display in real size, to many people, a full 1:50k topographical map in full colour or show any information in windows (video signal, messages, status report, etc.). It may be used in many ways, on a table (flat or perpendicular), hanged on a wall or on a pedestal. It's made 100% from Commercial-of-the-Shelf (COTS) components. It may be used in confined location, has a high portability and is unaffected by magnetic fields. Moreover, the mean chromaticity of the four PDPs has been measured at DREV with a Photo Research PR-650 spectroradiometer and gave the confirmation that its colour reproduction capability is relatively similar to that of common CRT (Ref. 5). The Blue colour is not as saturated as the CRT's one but the colour rendition is very good. The colour measurement results are listed in Table. III and the corresponding CIE-1931 chromaticity chart is illustrated in Fig. 6.

To be objective, it is important to highlight some limitations of the ToMaDi system. The local resolution of 38.5ppi is much lower than the 80ppi limit for appropriate topographical map visualization. The ToMaDi usage has confirmed this fact and limits its

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usage to 2X zoomed topographical map visualization.

The black cross in the middle of the screen, made by the difference between the effective display area and the PDP outer dimension, has a width of 2" and produce a visual fill factor of 88%³. This space, named mullion, is not mechanically "removable" because it is made by the electrical interconnections between the driving electronic circuits and the PDP's glass plate. For the given ToMaDi's active display area, the 2" mullion is detrimental to the visual comfort and constitute a serious limitation for real-life usage. The mullion can (with difficulty) be removed by using flat fresnel lenses at the expense of a thicker display (4' instead of 6"). Also, the A/D interfaces has some time jitter which produces "fuzzy edge distortions". It has to be adjusted from time to time by using the OSM.

5.0 FUTURE WORK

The guideline for the future work should be based on ToMaDi's limitations. To both minimize the adjacent borders between the FPDs and maximize the local resolution, many medium sized LCDs (13" to 15" diagonal) which have thin border, like the ones used in laptop computers, may be put side by side in a 3 x 3 or 4 x 4 configuration. This way, if 14" XGA⁴ LCDs are used in a 4 x 4 configuration, the total resolution and the local resolution would be 4096 x 3072 (45" x 37") and 90ppi, respectively, while maintaining the mullion thickness at about 0.5". Moreover, the power consumption would be very low at about 200W.

To get rid of the "fuzzy edge distortions" induced by the Phase Locked Loop (PLL) of the A/D interface, the video signal from the computer to the LCDs should be full digital like DVI (Ref. 6) or DFP (Ref. 7) standards.

6.0 CONCLUSION

The main goal of this technical memorandum was to describe and explain every aspects related to the development of a large colour plasma display designed, engineered and assembled at DREV, the ToMaDi system. It was shown, despite its limitation, that To-

3. Defined by the ratio of the total display area over the surface bounded by the four display area.

4. Extended Graphics Array: 1024 x 768 pixels.

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MaDi is an effective substitute to topographical maps and this result is sufficiently positive to warrant both follow-up studies in advanced display systems and ToMaDi applications for the Department of National Defence.

7.0 ACKNOWLEDGEMENTS

The author wishes to express his gratitude to the DREV's Prototype Section including Messrs. Jean-Claude Drolet, Alain Senécal, Denis Gouin, Gaétan Thibault and the Maj. Michel Gareau for their assistance during the ToMaDi development.

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5. http://www.videoessentials.com/jkp_facts.htm
6. <http://www.ddwg.org/>
7. <http://www.vesa.org/dfplink.html>

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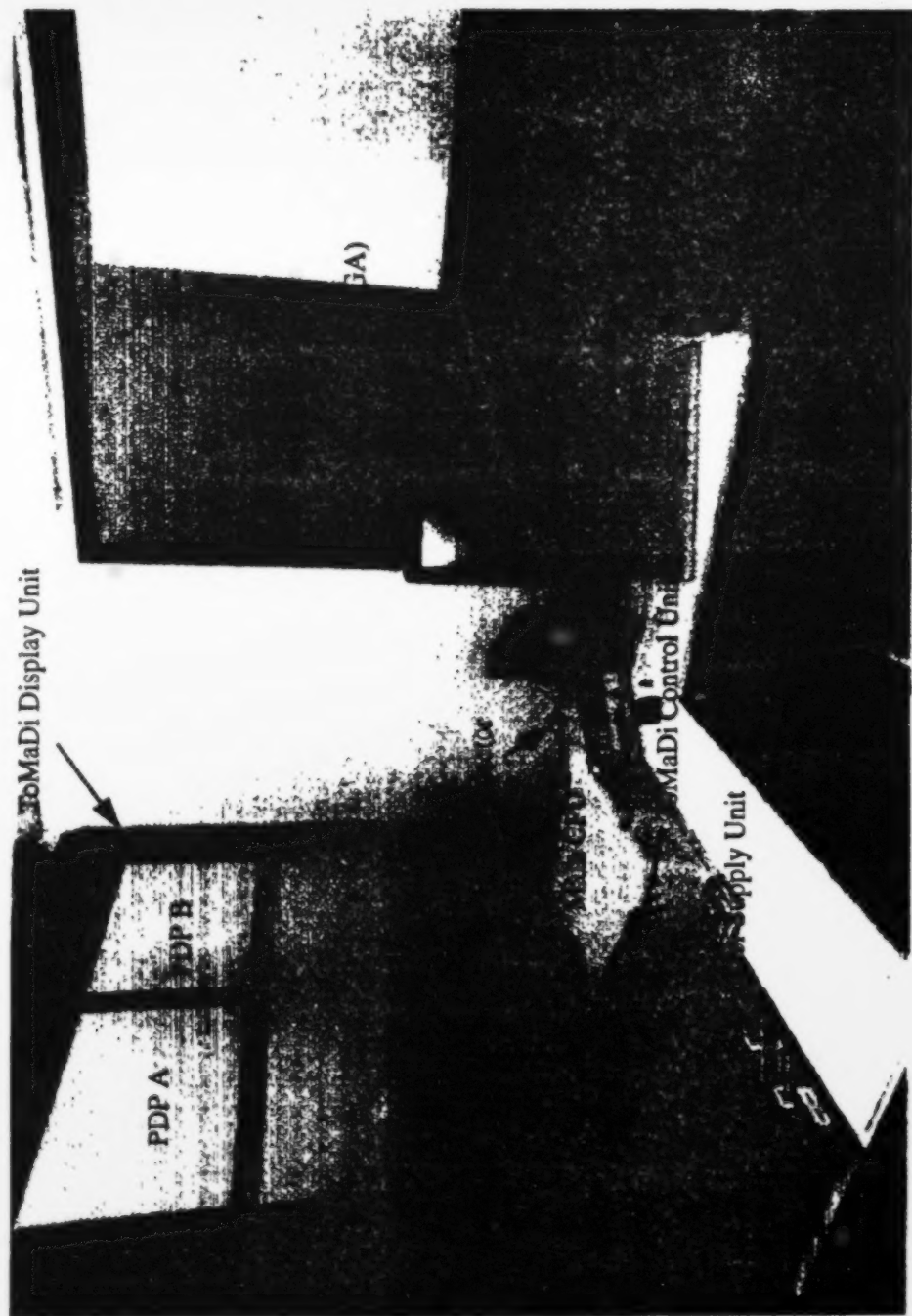


FIGURE 1 - The ToMaDi Setup

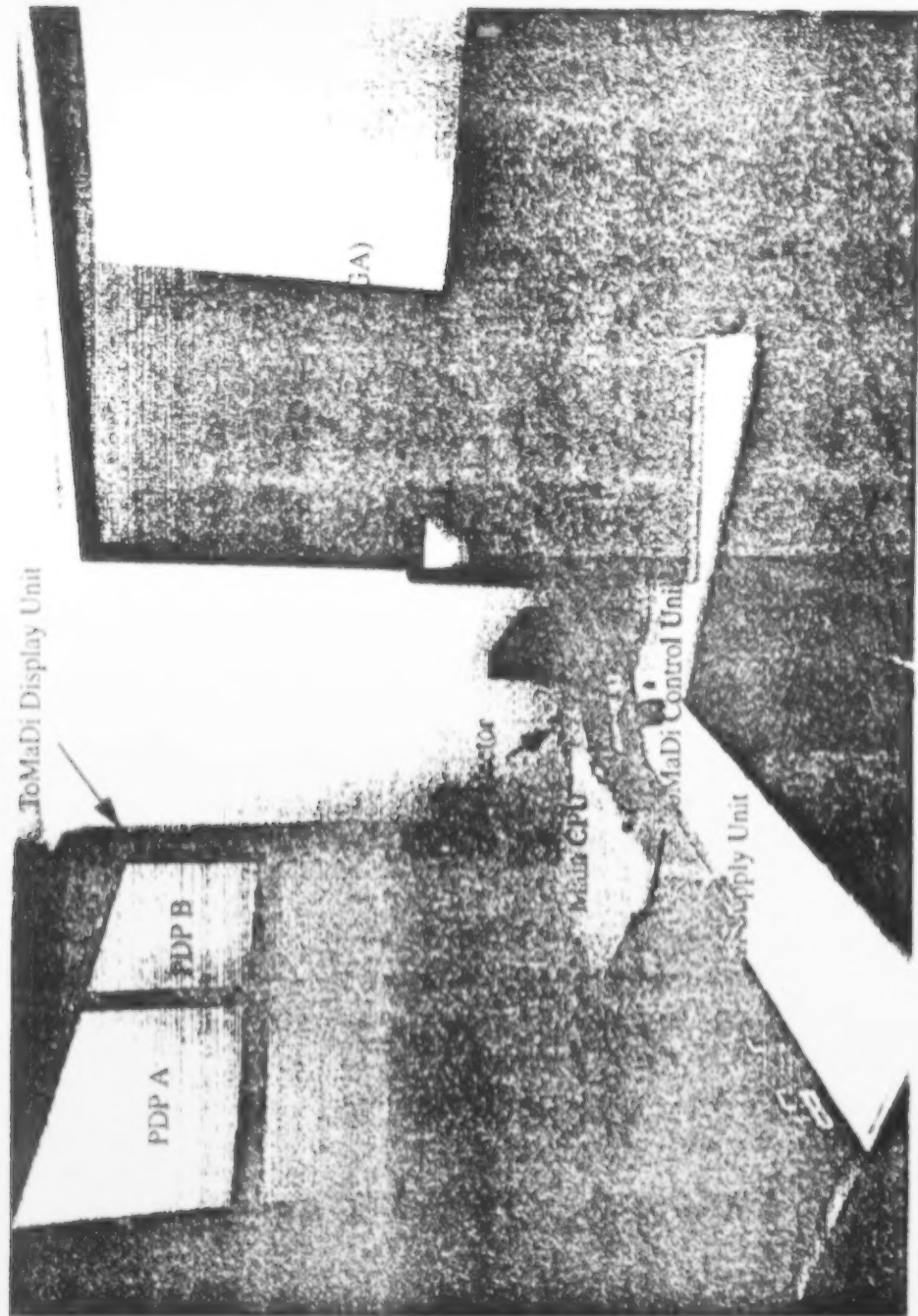


FIGURE 1 - The ToMaDi Setup

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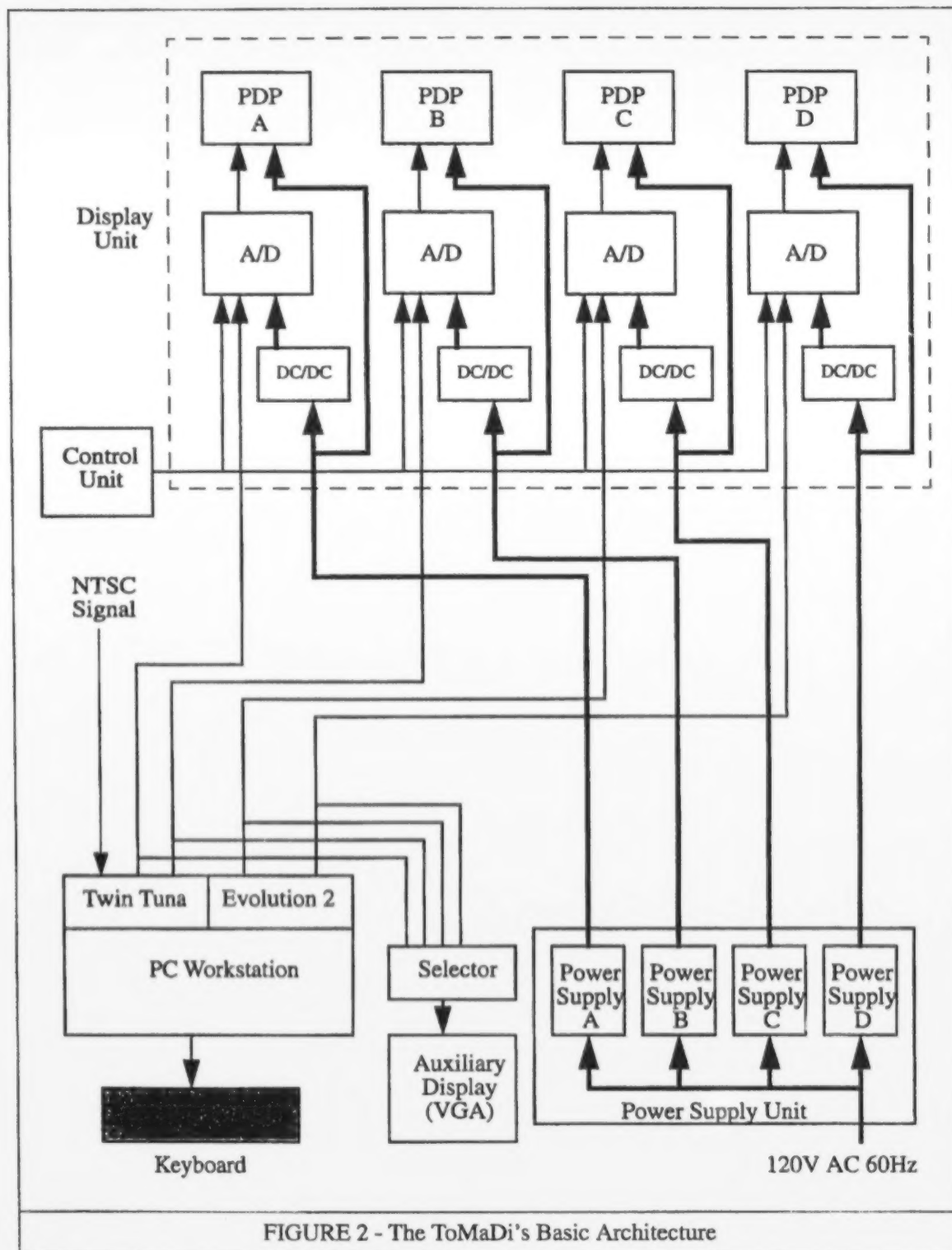
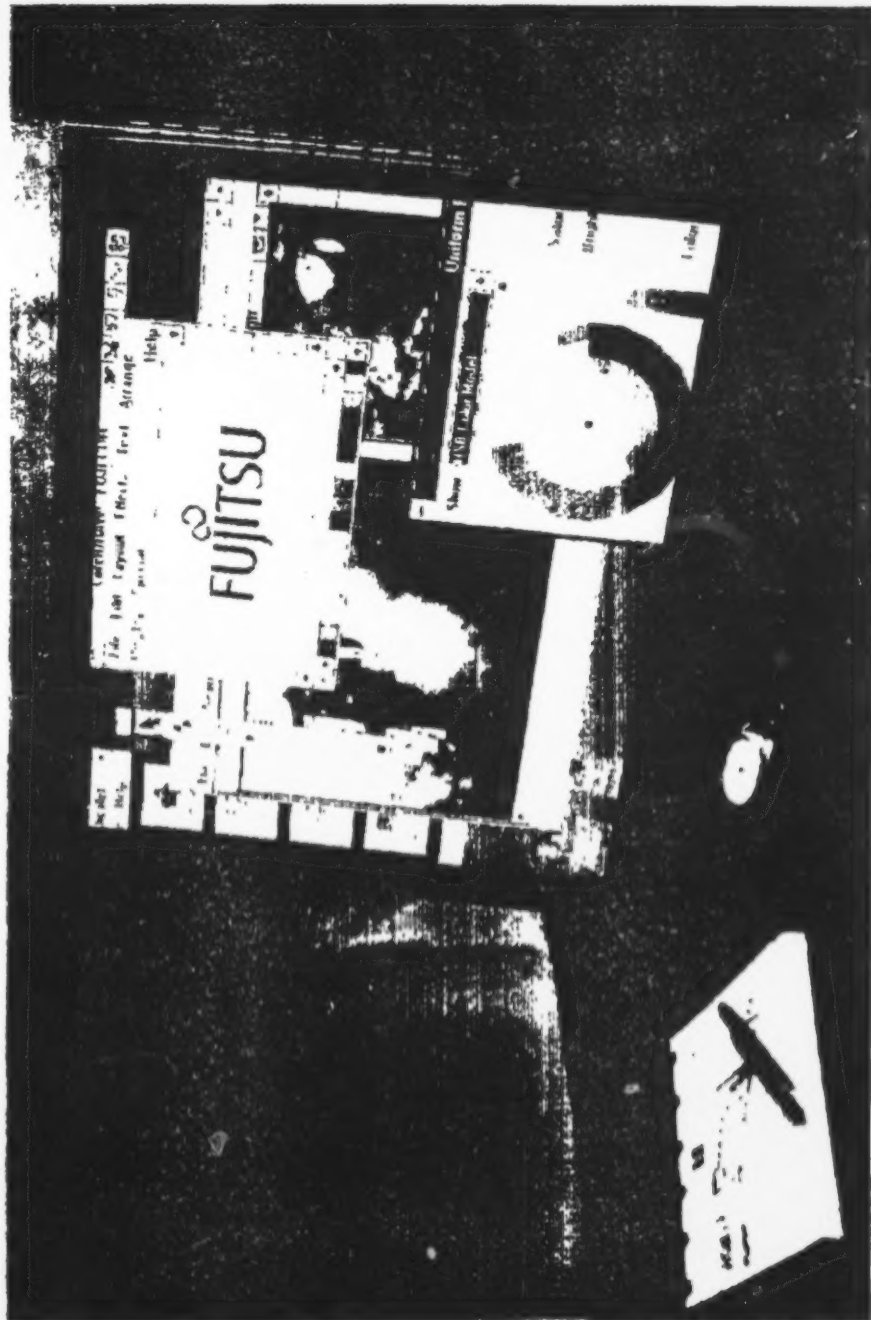


FIGURE 2 - The ToMaDi's Basic Architecture

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Courtesy of Fujitsu Ltd.

FIGURE 3 - The Fujitsu's FPF21C8060UA-02 Plasma Display Panel

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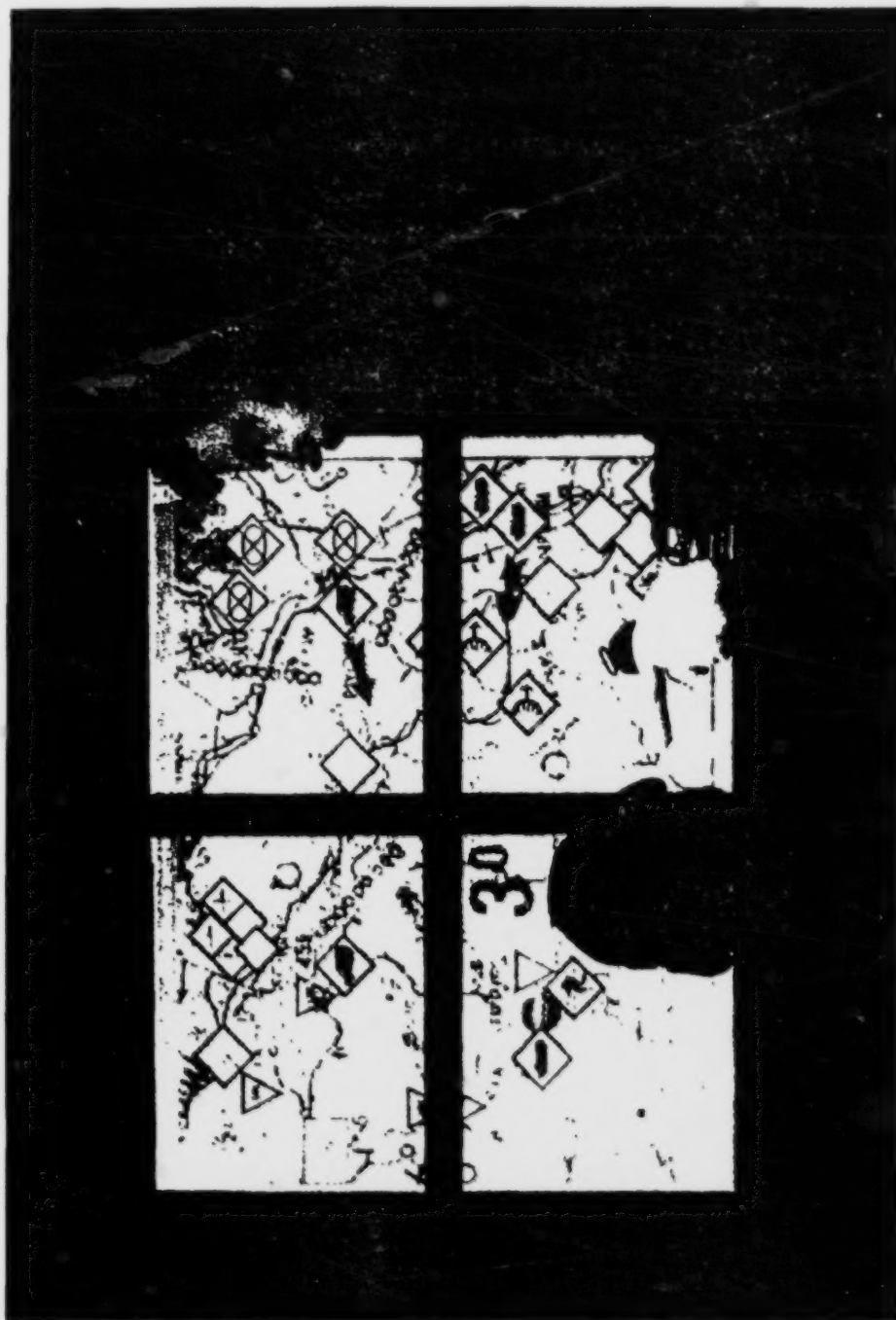
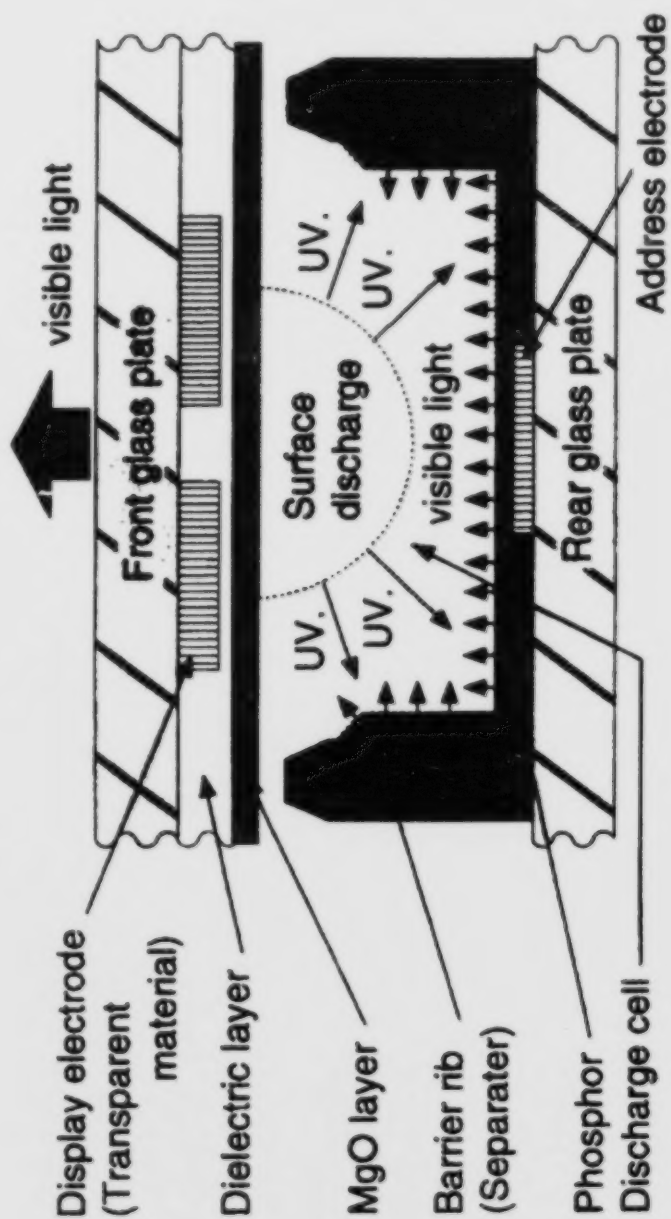


FIGURE 4 - Exemple of a tactical map displayed by ToMaDi

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Courtesy of Fujitsu Corp.

FIGURE 5 - PDP Operation Principle

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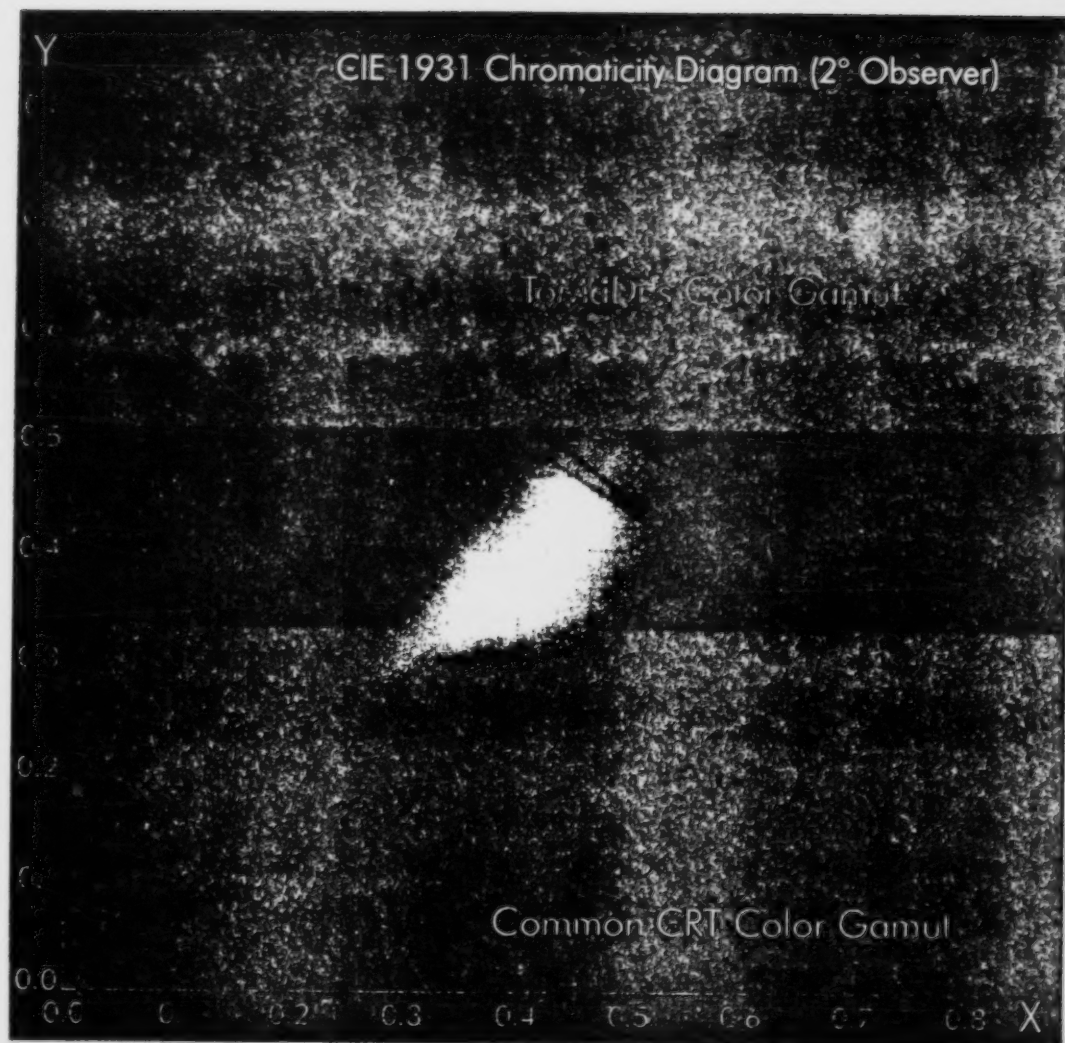


FIGURE 6 - The CIE 1931 chromaticity diagram for ToMaDi and common CRTs

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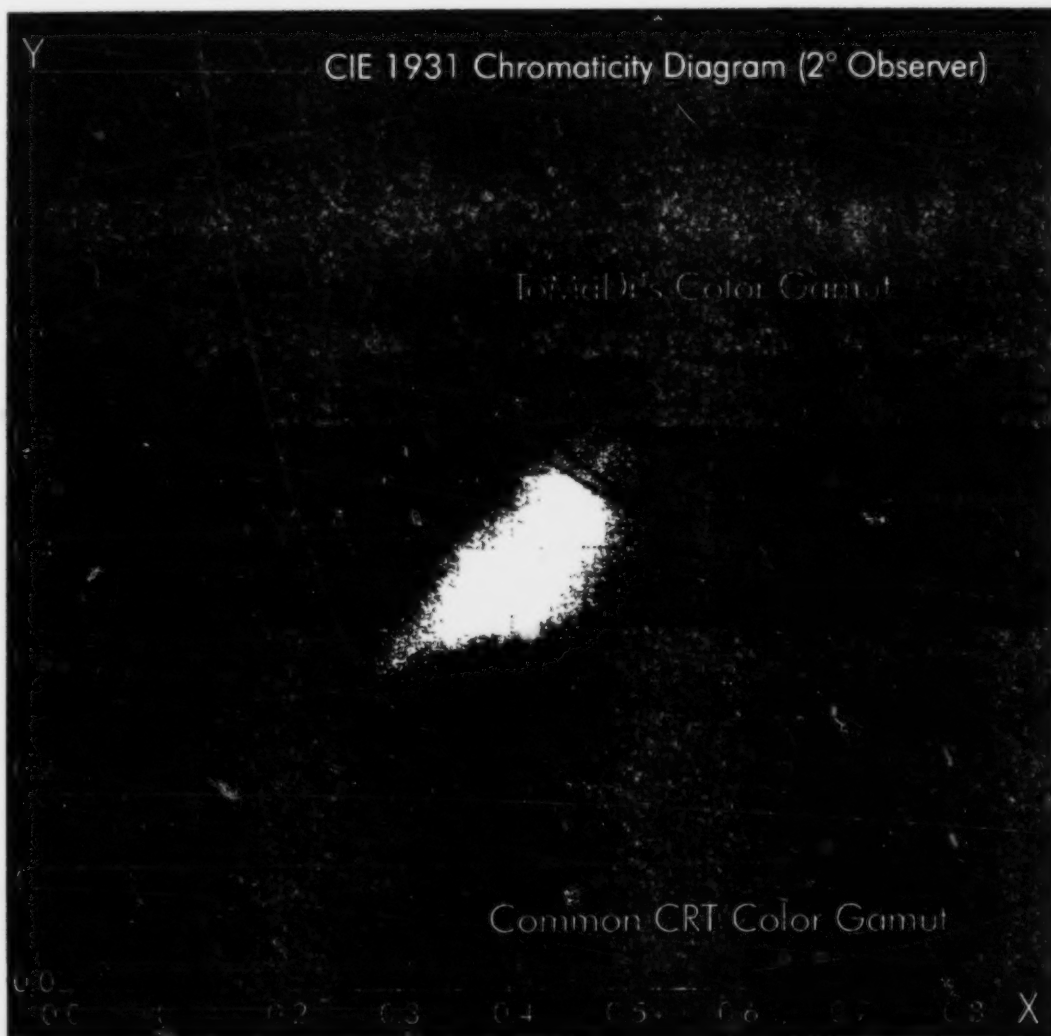


FIGURE 6 - The CIE 1931 chromaticity diagram for ToMaDi and common CRTs

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TABLE I**List of FPDs Available on the Market**

Company	Technology	Dimension (diag)	Local Res- olution (dpi)	Total Reso- lution	Available in Q1 97?
Mitsubishi	LCD	13"	126	1280x1024	yes
Sharp	LCD	13,8"	93	1024x768	yes
Mitsubishi	LCD	14,2"	90	1024x768	yes
Kyocera	LCD	15"	86	1024x768	yes
Mitsubishi	LCD	15"	108	1280x1024	no
IBM	LCD	16"	102	1280x1024	yes
Sharp	LCD	17,7"	72,4	1024x768	yes
dpiX	LCD	19"	86	1280x1024	no
NEC	LCD	20"	81	1280x1024	no
NEC	LCD	20"	102	1600x1280	no
Fujitsu	Plasma	21"	38	640x480	yes
Photonics	Plasma	21"	78	1280x1024	no
Samsung	LCD	21,3"	94	1600x1200	no
Thomson	Plasma	24"	67	1280x1024	no
Samsung	LCD	30"	67	1600x1200	no
NEC	Plasma	33"	24,2	640x480	limited
Mitsubishi	Plasma	40"	20	640x480	yes
Sharp	LCD	40"	25	800x600	no
Fujitsu	Plasma	42"	23,5	852x480	yes
NEC	Plasma	50"	31.3	1365x768	no
Revision: october 98					

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TABLE II**ToMaDi's PC Characteristics**

Double Pentium-Pro processor, 200MHz, 256k cache (each)	Microsoft Windows NT 4.0 for workstation
10Base-T Ethernet (RJ45) 3Com Etherlink III	Microsoft System Mouse F3
128M EDO-RAM	Audio 16 bits (Soundblaster 16)
1 Twin-Tuna and 1 Evolution-2 Color-graphic Video adapters	Speakers (Altec ACS90)
Adaptec 2940UW SCSI ctrl.	Free PCI slot (when there are no video cards): 4
4Gig SCSI Hard Disk	Desk top model
8X SCSI CD-ROM Drive	230W power supply
One 3.5" floppy	DR-4 Tape Backup

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TABLE III**ToMaDi's Mean Colour Measurement Results**

	TOMADI		Common CRT ^a	
	X	Y	X	Y
Red	0.613	0.358	0.628	0.346
Green	0.276	0.618	0.268	0.588
Blue	0.2023	0.155	0.150	0.070

a. for comparison purposes

Measurement Conditions: The measurements was done with a Photo Research PR-650, the angle of incidence was 90° and the measuring distance was 7 feet. The room was dark and the TOMADI warm up time was 2 hrs.

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APPENDIX A

Example of Maps Displayed at Different Resolutions

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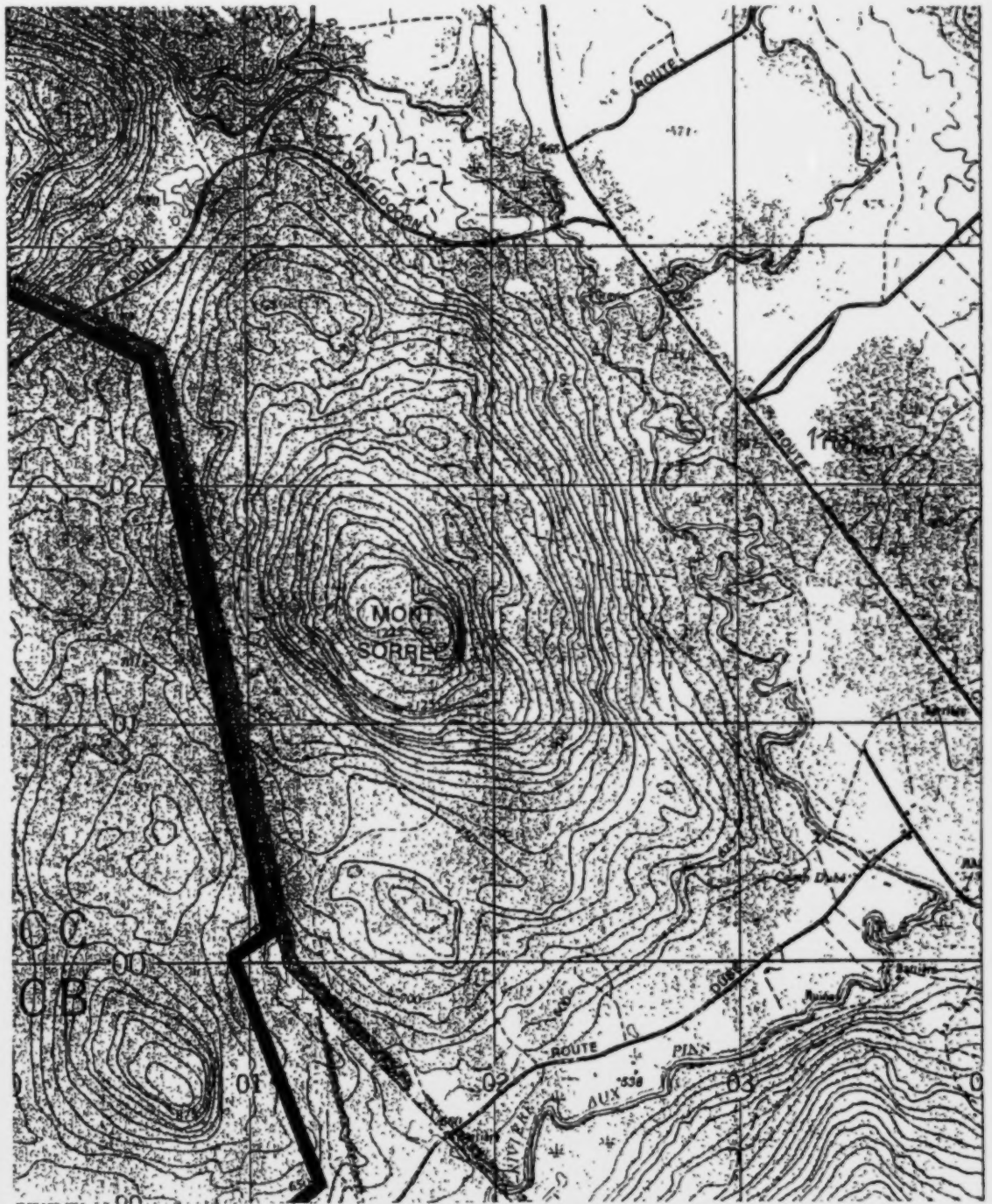


FIGURE A1 - Example of a map digitized at 150 ppi

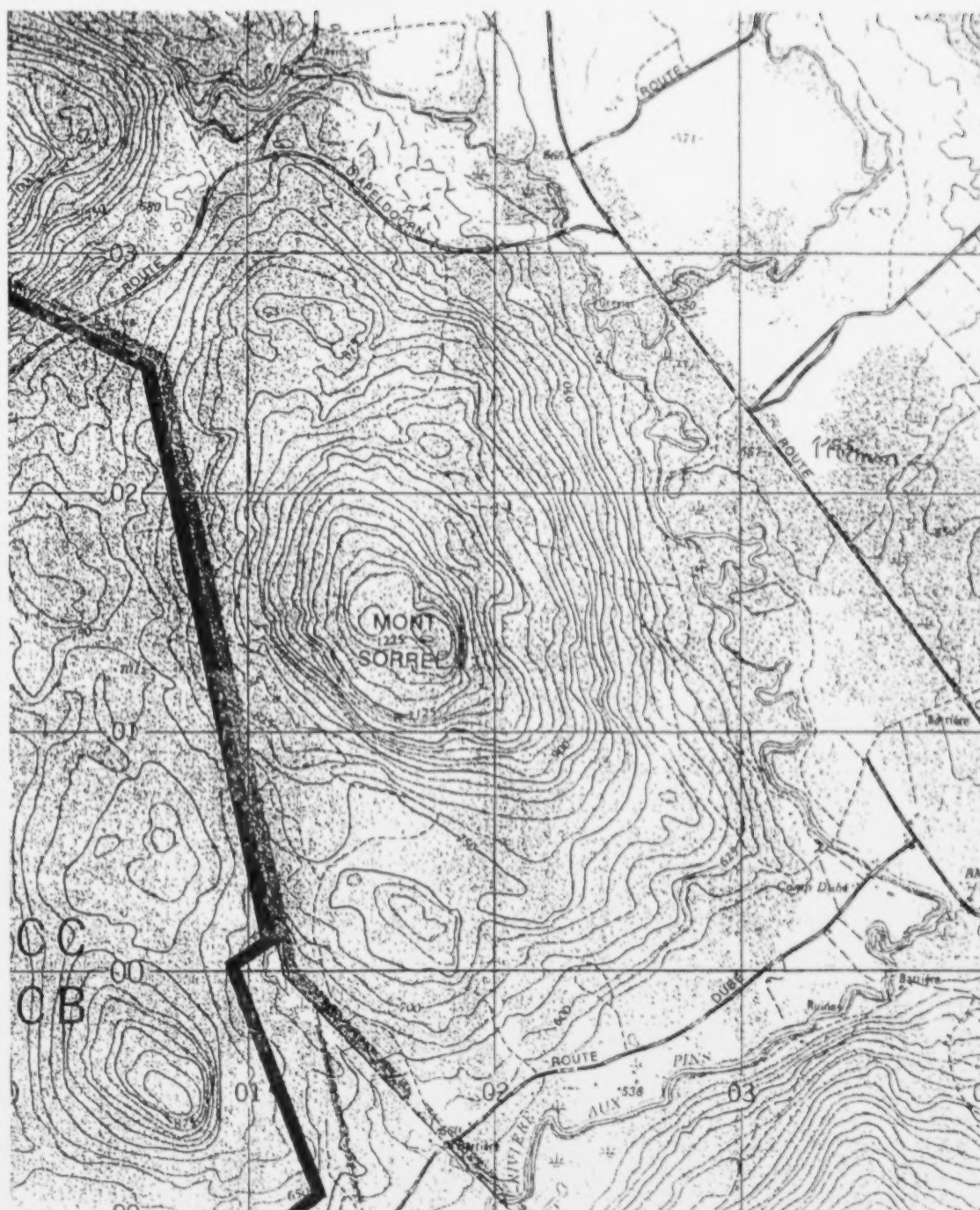


FIGURE A1 - Example of a map digitized at 150 ppi

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A2

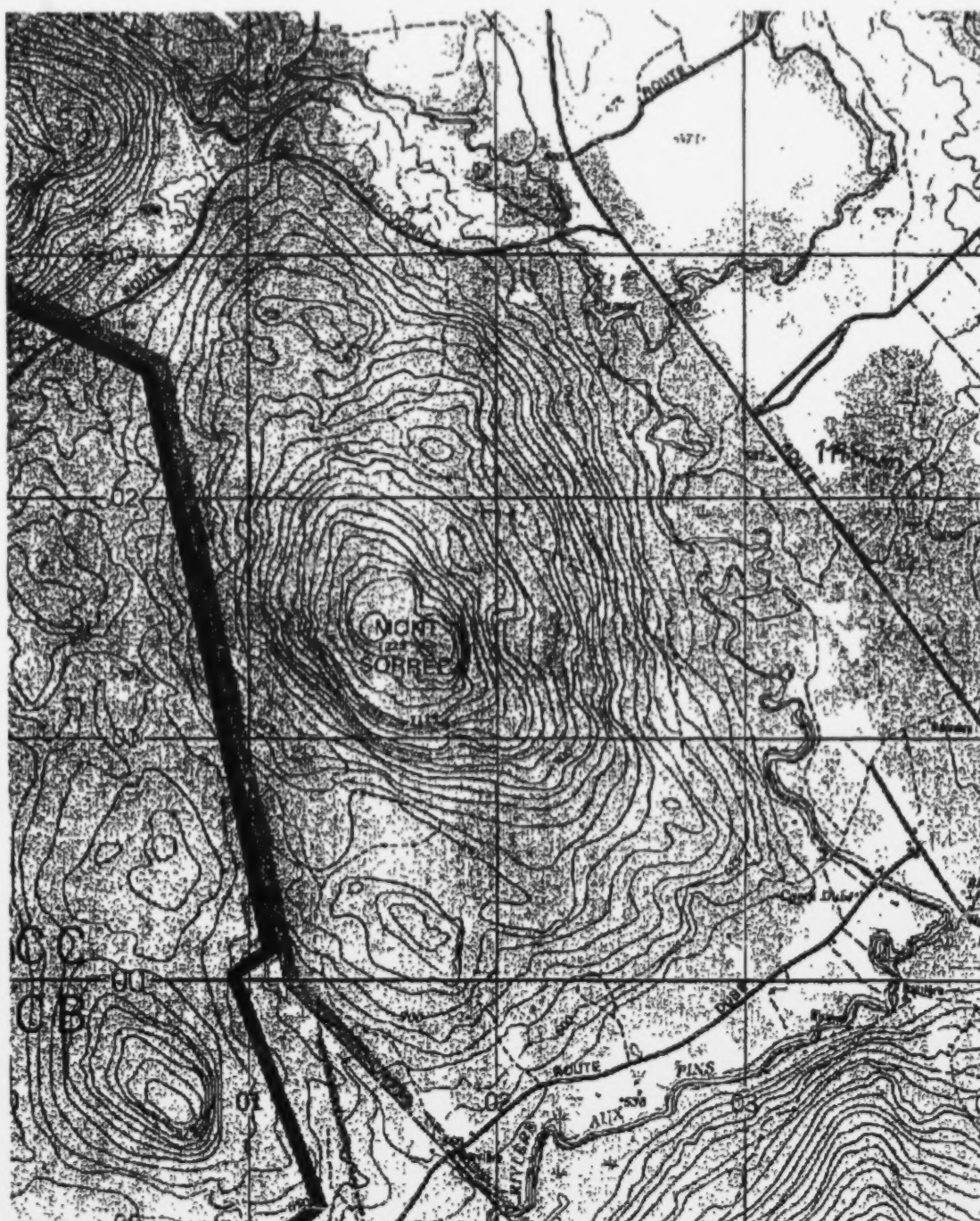


FIGURE A2 - Example of a map digitized at 100 ppi

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A3

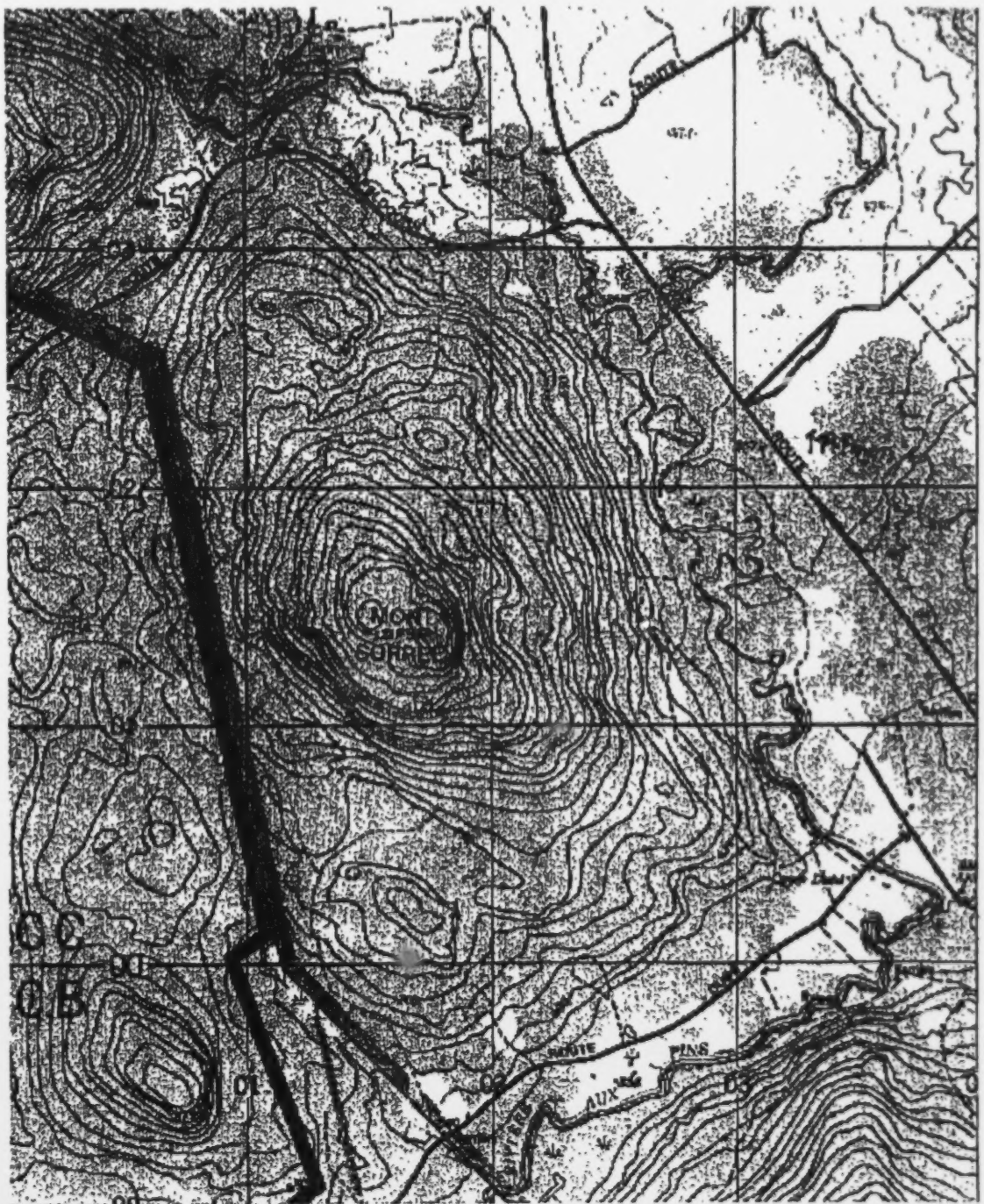


FIGURE A3 - Example of a map digitized at 75 ppi

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A4

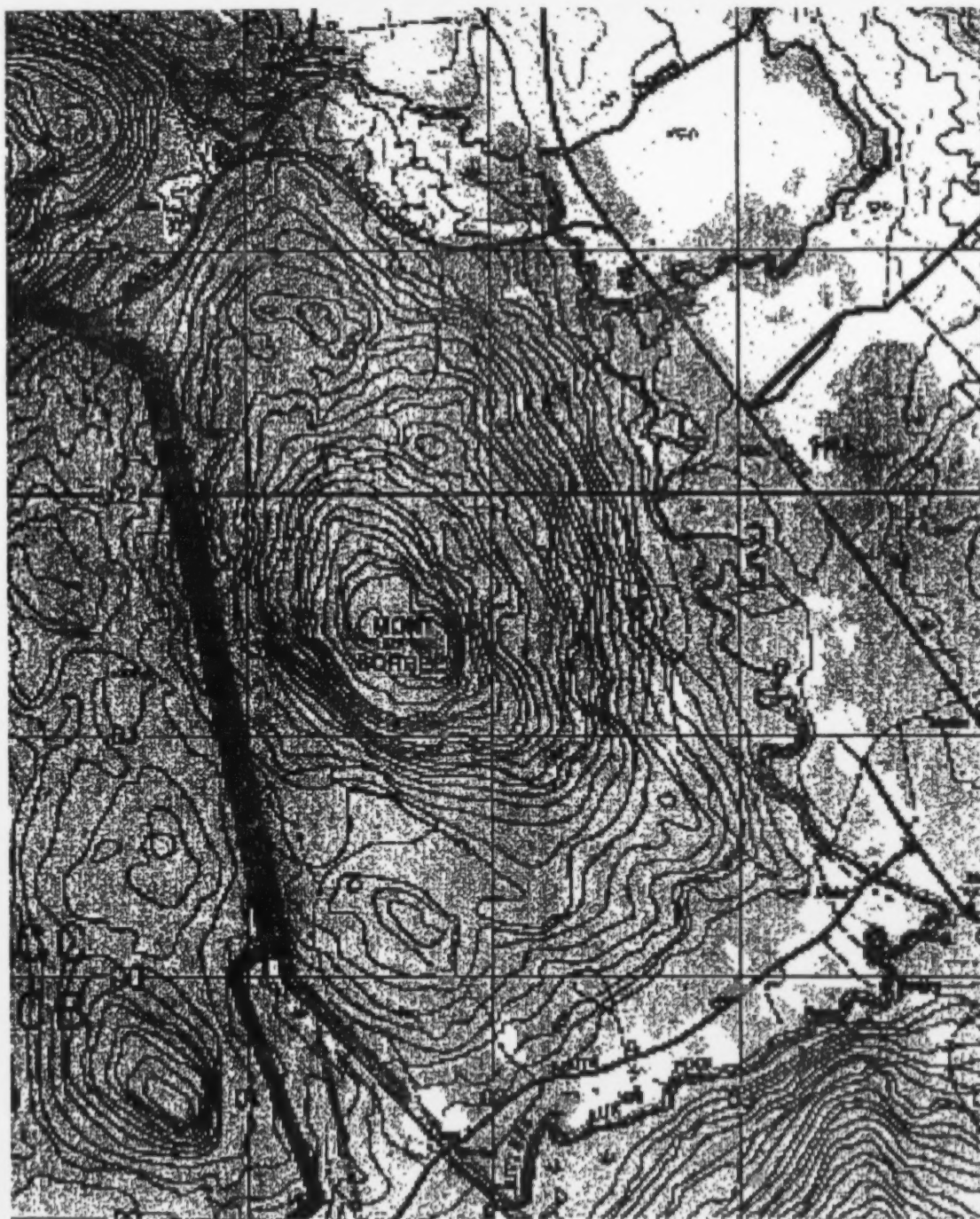


FIGURE A4 - Example of a map digitized at 50 ppi

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A5

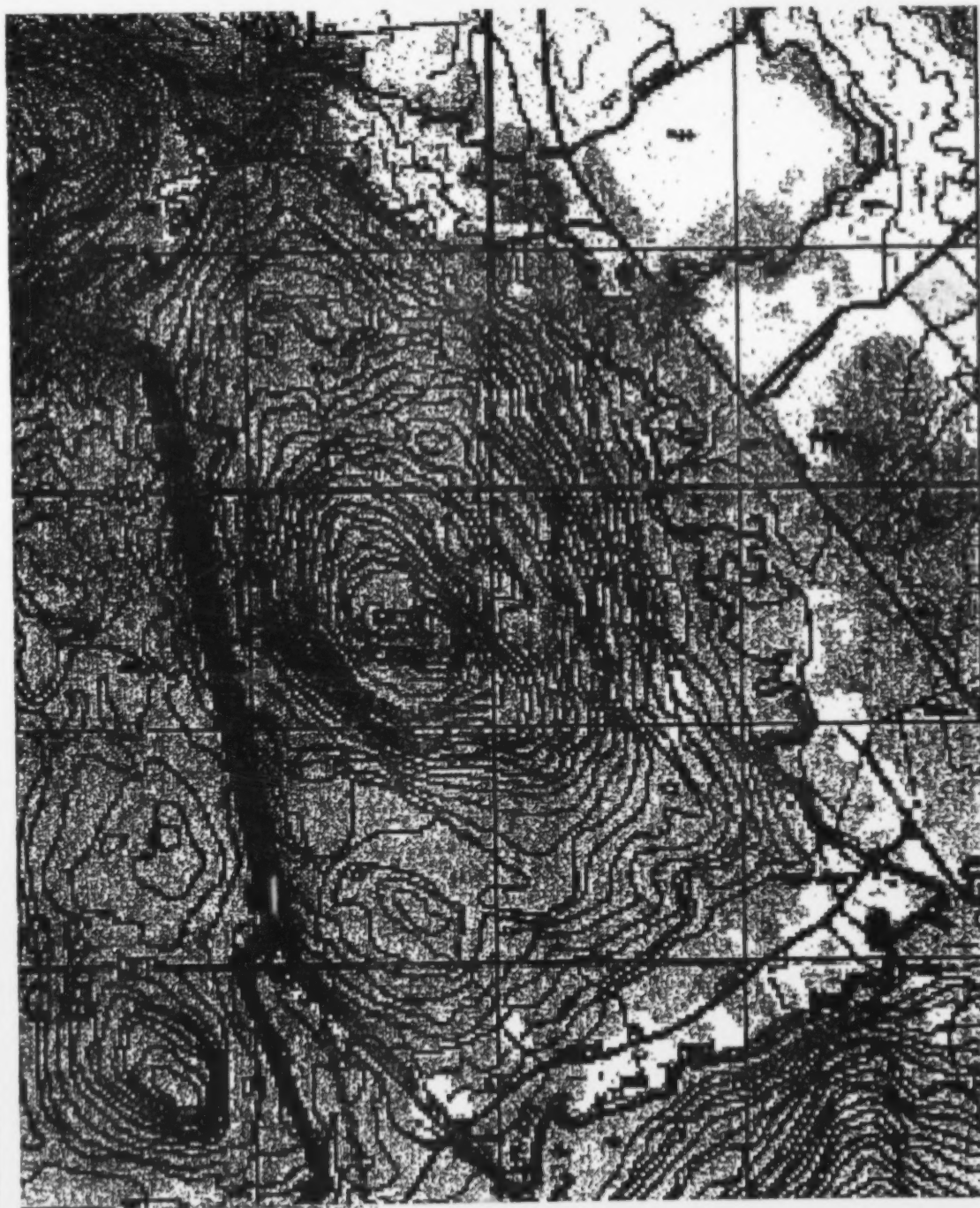


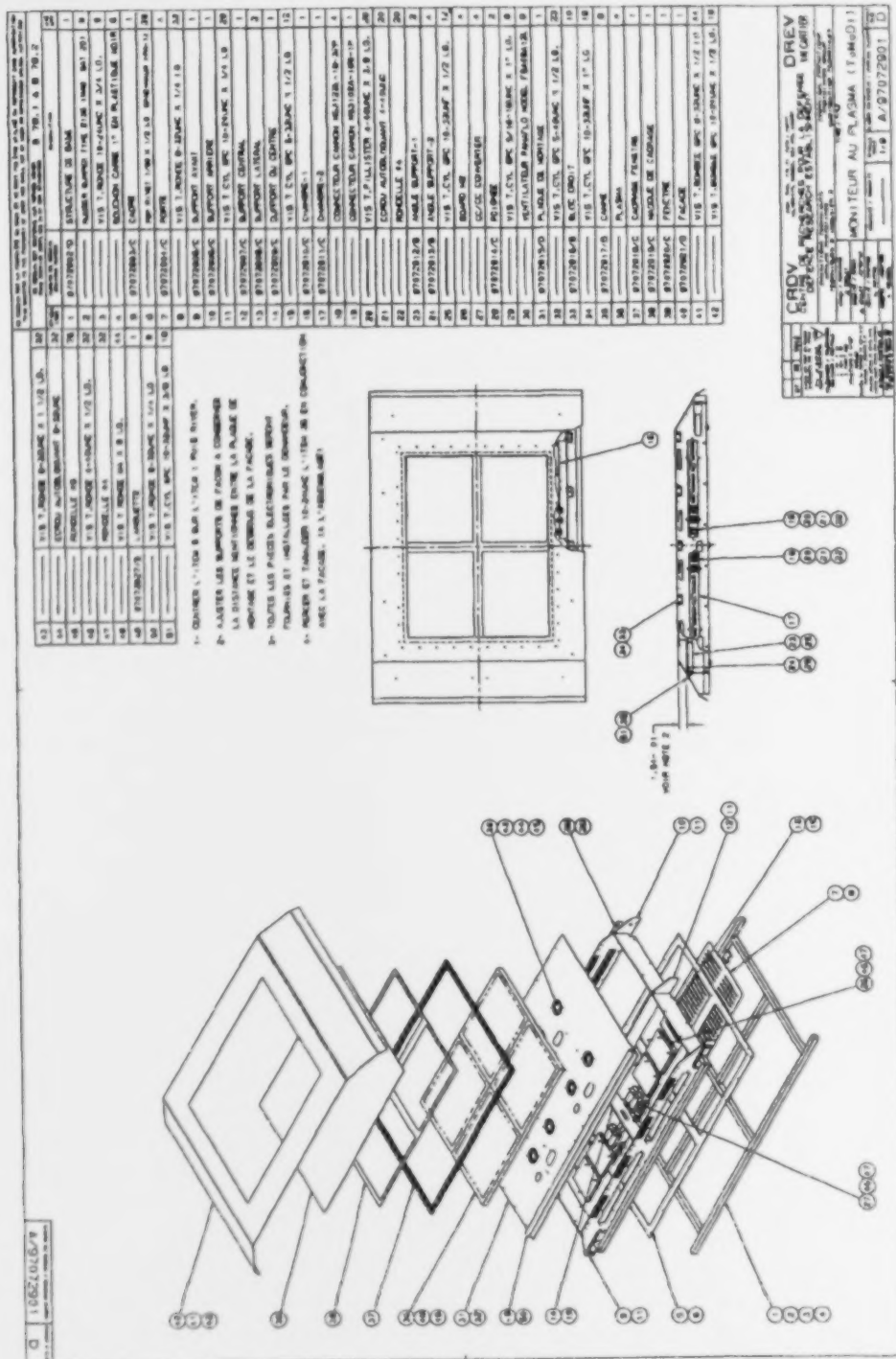
FIGURE A5 - Example of a map digitized at 37,5 ppi

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APPENDIX B

ToMaDi Principal Assembly Drawings

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B1



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B5

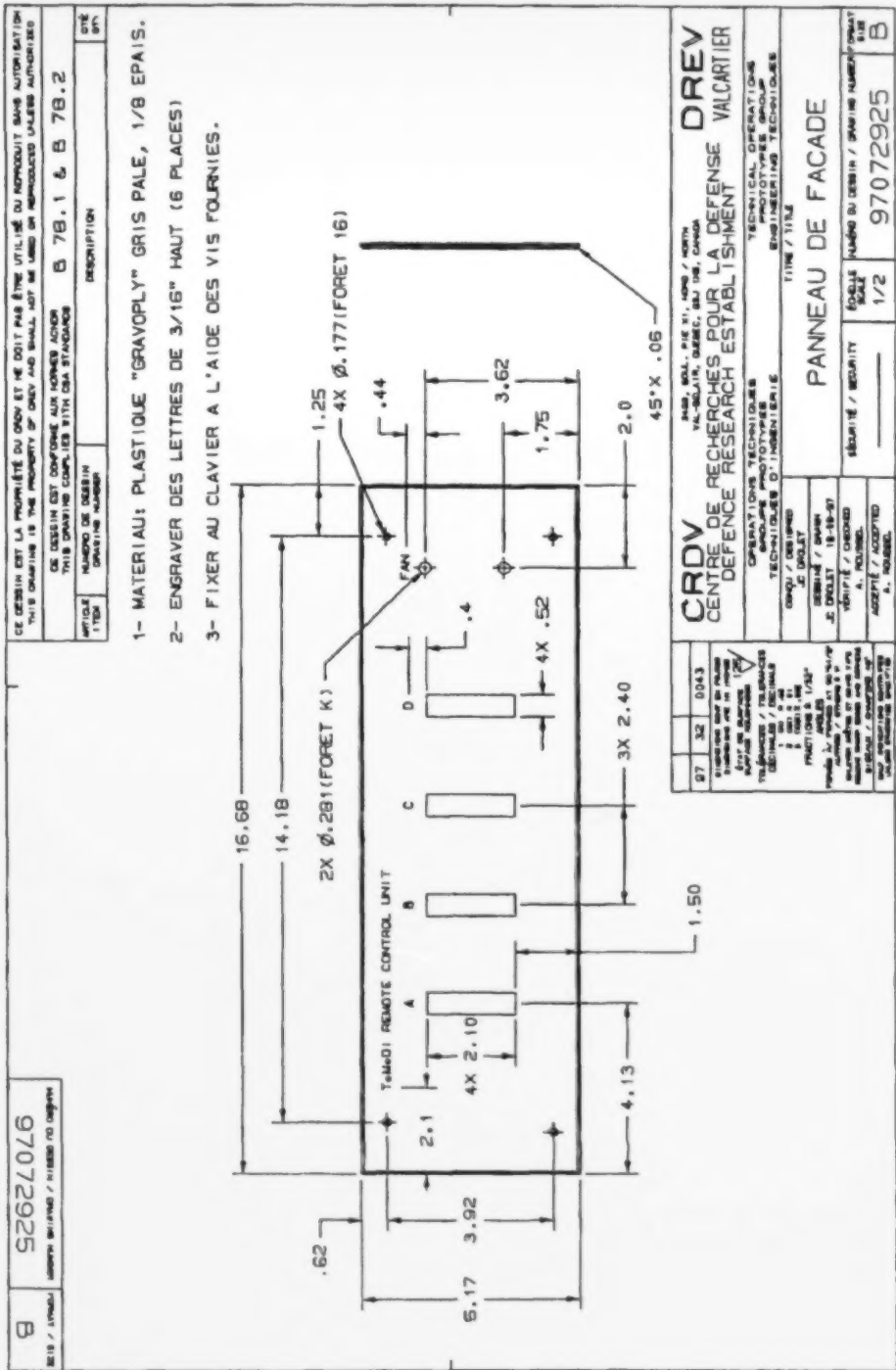


FIGURE B5 - TOMADI Remote Control

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B6

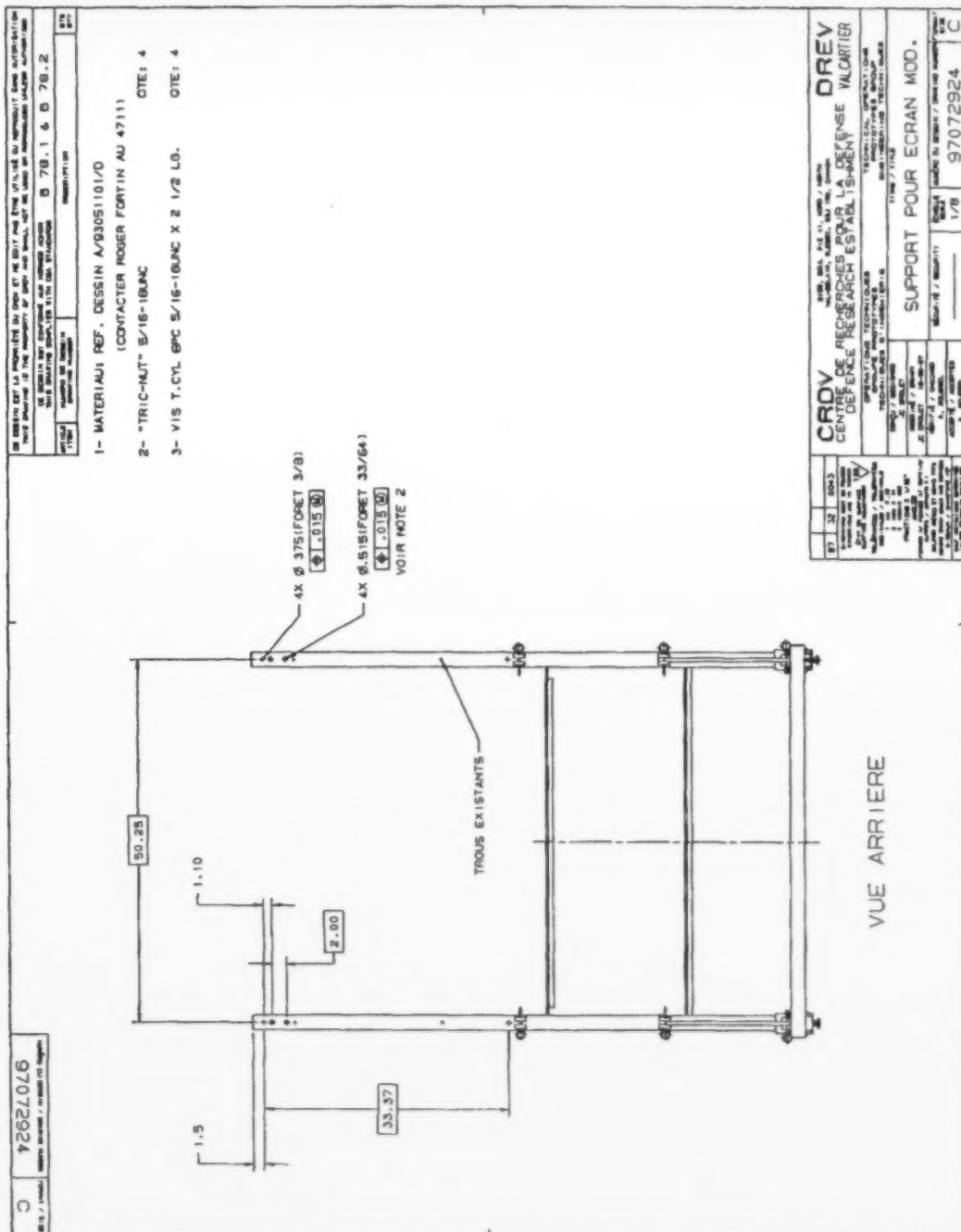


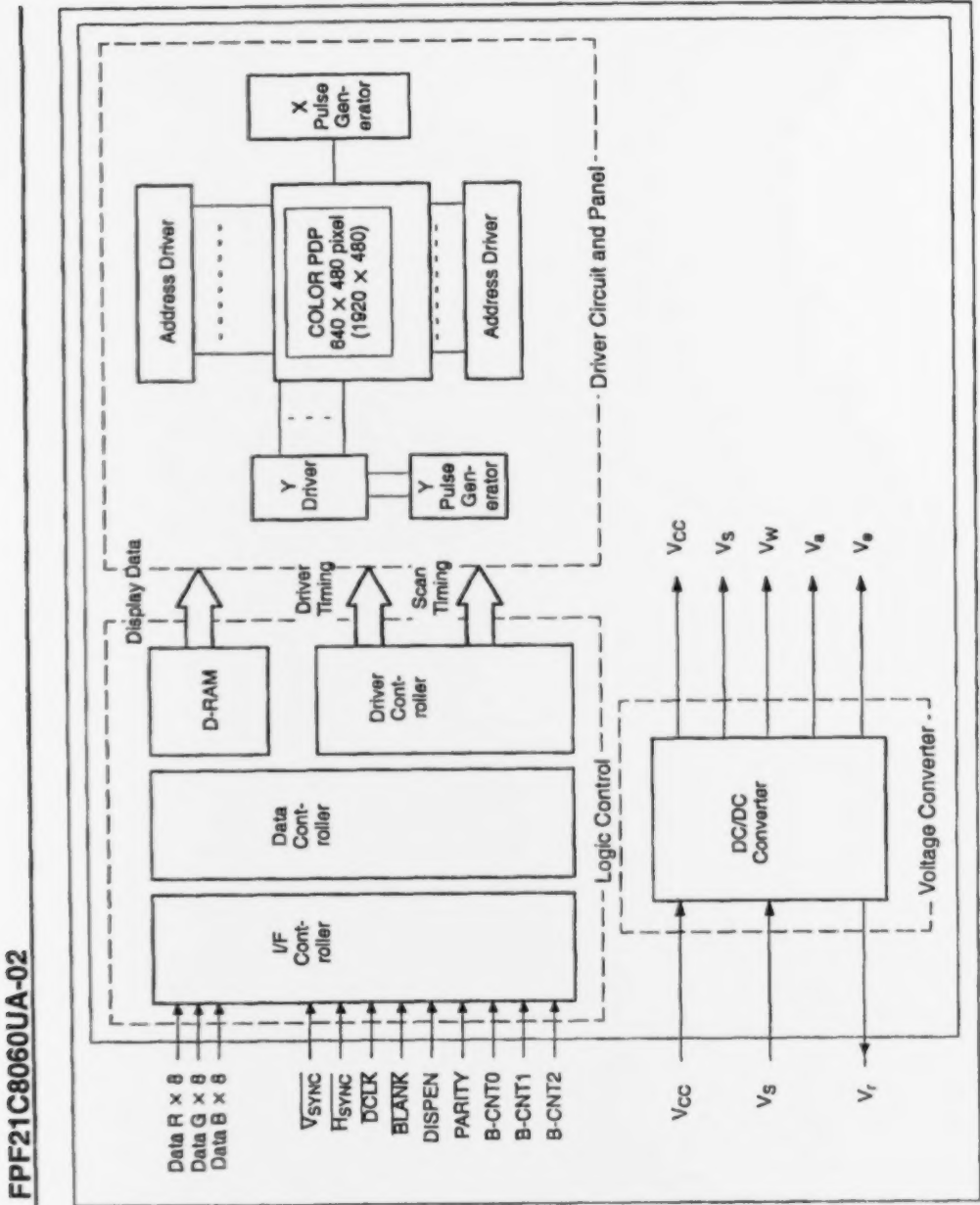
FIGURE B6 - TOMADI Display Support

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APPENDIX C

Fujitsu's FPF21C8060UA-02 Characteristics

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FIGURE C1 - PDP Block Diagram

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C2

FPF21C8060UA-02

SPECIFICATIONS

DISPLAY PERFORMANCE

No.	Item	Rating
1	Display Pixels	Horizontal 640 × Vertical 480 (1 pixel = 3RGB cells)
2	Display Cells	Horizontal 1920 × Vertical 480 cells
3	Pixel Pitch	Horizontal 0.66mm × Vertical 0.66mm
4	Cell Pitch	Horizontal 0.22mm × Vertical 0.66mm
5	Display Pixel Type	RGB Stripe (shown in Figure 2)
6	Effective Display Size	Horizontal 423mm × Vertical 316mm (21" to corners) (16.65" (H) × 12.44" (V))
7	Number of Colors	260,000 (64 gradations of RGB)
8	Brightness ¹ (Average brightness)	White: over 120cd/m ² (display rate 25%, max. gradations setting, V _{sync} = 16.7msec.)
9	Contrast ² (in dark room)	over 60:1 (Brightness at max. gradation 25% light/no light brightness)
10	Maximum Viewing Angle ³	over 140°

NOTES:

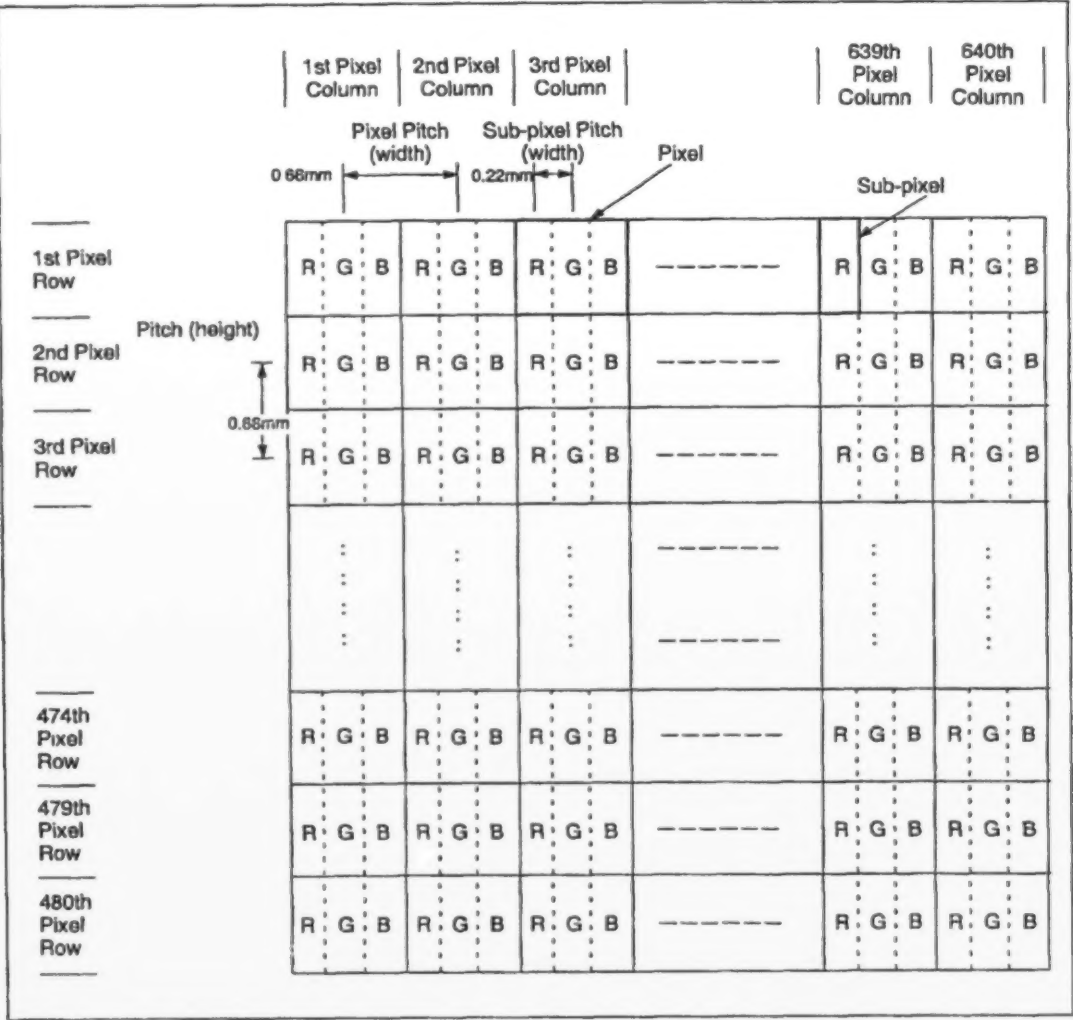
1. Brightness is the average of the 9 points, which are uniformly arranged on the panel display area. (Total display rate: 25%, max. gradation.)
2. Contrast is calculated from the display brightness and the non-display brightness is calculated from the values in note 1. Contrast = average brightness/non-display brightness.
3. Viewing angle is the critical angle at which characters can still be read.

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TABLE C1 - PDP Display Performance

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FIGURE C2 - PDP Dot Diagram

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MECHANICAL SPECIFICATIONS

No.	Item	Rating
1	Max Outer Dimensions	Width 480mm (18 90") × Height 400mm (15.75") × Thickness 32mm (1.26") (see Package Dimensions)
2	Weight	under 5.0kg (11.16 lbs.)

MECHANICAL CHARACTERISTICS

No.	Item	Rating	
1	Vibration	Operational	Acceleration: under 0.5G, Frequency: 10~55Hz Time: 5 minutes (X, Y, Z directions)
		Non-operational	Acceleration: under 0.5G, Frequency 10~55Hz Time: 2 hours (X, Y, Z directions)
2	Impact	Non-operational	Acceleration: under 40G (X, Y direction) under 20G (Z direction) Time: 11msec

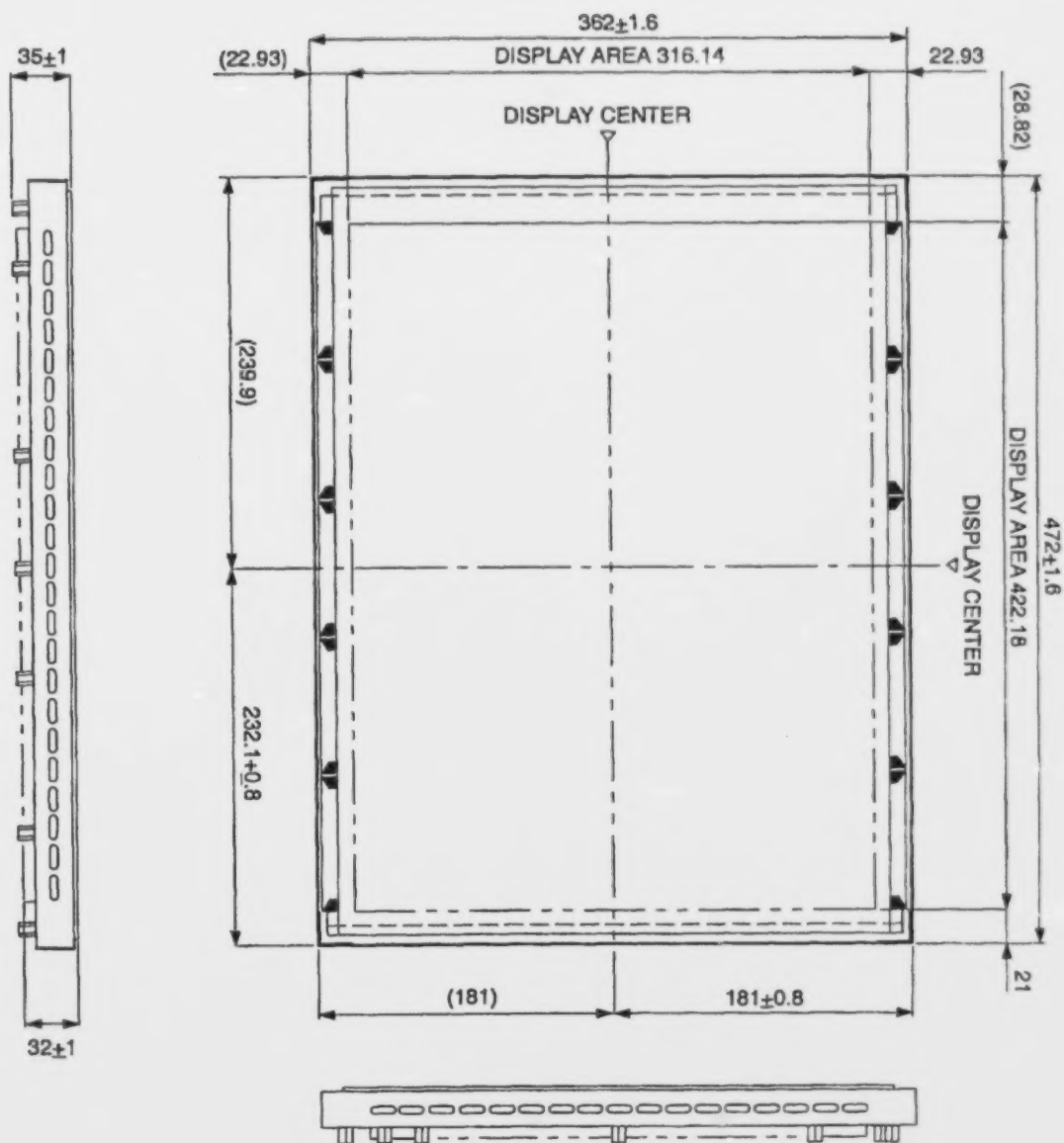
ENVIRONMENTAL CHARACTERISTICS

No.	Item	Rating	
1	Temperature	Operational	0°C ~ 45°C (max. glass panel surface temp. under 80°C)
		Non-operational	-20°C ~ 70°C
2	Humidity		20 ~ 85% RH
3	Pressure		800 ~ 1114hPa (Altitude 0 ~ 2000m)

Courtesy of Fujitsu Ltd.

TABLE C2 - Mechanical and Environmental Characteristics

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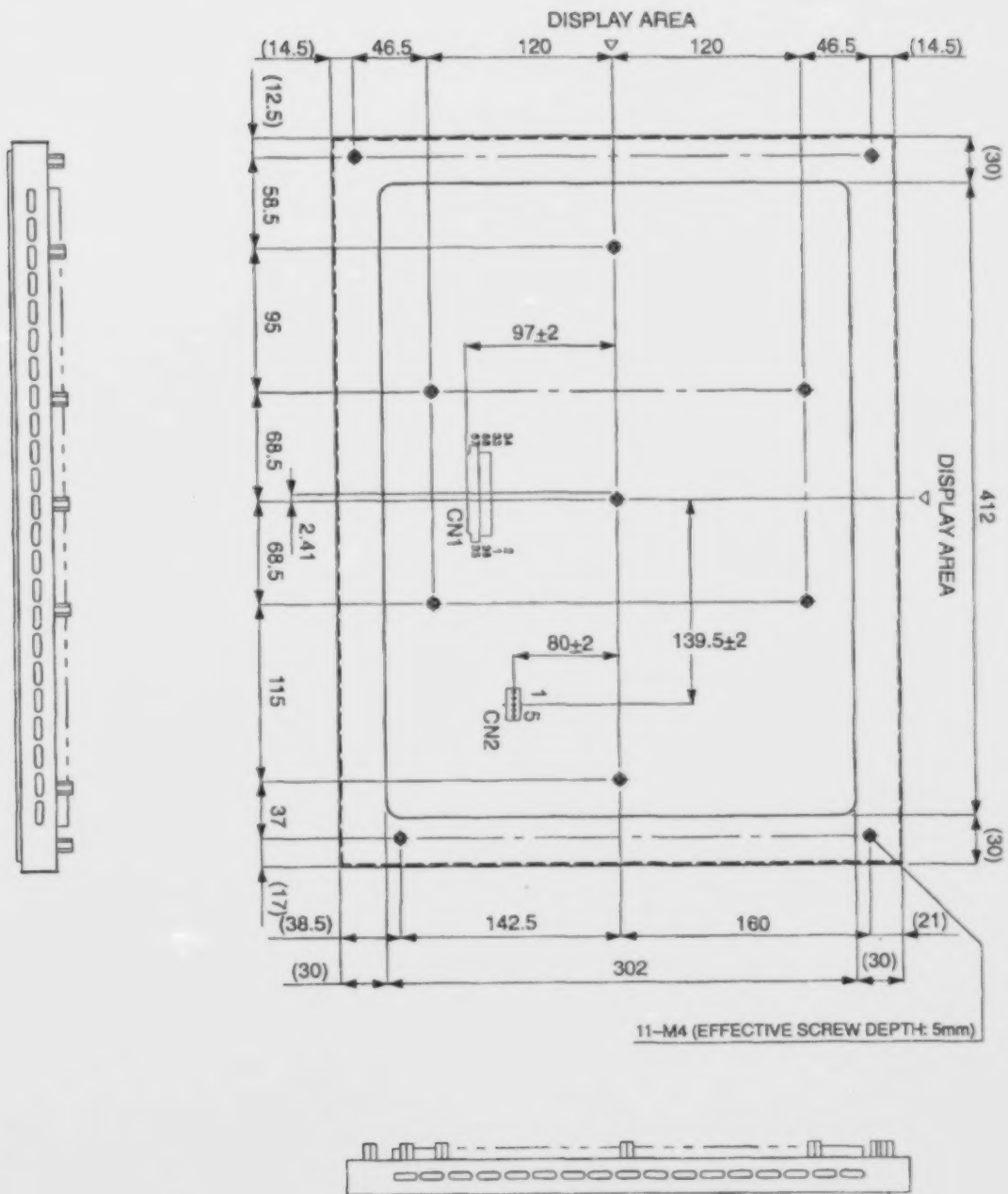


Unit: mm

Courtesy of Fujitsu Ltd.

FIGURE C3 - PDP Package Dimensions (Front View)

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Courtesy of Fujitsu Ltd.

Unit: mm

FIGURE C4 - PDP Package Dimensions (Back View)

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ELECTRICAL CHARACTERISTICS

MAXIMUM ABSOLUTE VOLTAGE RATING

No.	Item	Symbol	Absolute Max. Rating	Unit
1	Logic Voltage	V_{CC}	7.0	V
2	Panel Driver Voltage	V_S	200	V

INPUT POWER TYPE AND SPECIFICATIONS

No.	Item	Symbol	Term/Condition	Value			Unit
				Min.	Typ.	Max.	
1	Panel Driver Voltage	Voltage	V_S Auto setting (170 + 10 × V_I)	170		195	V
		Ripple/Noise	V_{NRS} Load Resistance	—	—	500	mV
		Stability	— Load Resistance	—	—	± 1.5	%
		Setting Accuracy	— Deviation from expression (1)	—	—	± 0.5	%
		Current (average)	I_S	100	—	700	mA
		Current (instant)	I_{SP} Pulse Width: 2.0ms max. (no-pulse: 1.8ms)	—	—	4.0	A
2	Logic Voltage	Voltage	V_{CC} Fixed	4.75	5.0	5.25	V
		Ripple/Noise	V_{NRS} Load Resistance			200	mV
		Stability	— Load Resistance			± 5	%
		Power Flow (average)	I_{CC}	0.4	1.9	2.0	A

NOTES:

- In V_S Voltage Setting, the V_I signal is output from the unit.
- V_S Voltage will not be applied to the panel under the following conditions. Also, in this case, the sustain current (I_S) will be less than 50mA.
 - V_{CC} has not been applied.
 - 200ms after application of V_{CC} .
 - V_S Voltage is outside standard range.
 - No vertical synchronous signal input.
- V_S is suppressed to about 550mA by the Automatic Power Control function (APC), however, at start up (max. 5 seconds), a max. 1.4A current can be reached. APC setting value = 105W ± 10W. (APC start up display rate is approximately 40%.)

INPUT SIGNAL TYPES AND SPECIFICATIONS

No.	Item	Condition	Symbol	Value			Unit
				Min.	Typ.	Max.	
1	Input Voltage: TTL Level 1) "H" Level 2) "L" Level		V_{IH}	2.0	—	5.25	V
			V_{IL}	—0.5	—	0.8	V
2	Input Current: TTL Level 1) "H" Level 2) "L" Level	$V_I = 2.75V, V_{CC} = 5.25V$	I_{IH}	—	—	20	μA
		$V_I = 0.4V, V_{CC} = 5.25V$	I_{IL}	—	—	—16	mA

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TABLE C3 - PDP Electrical Characteristics

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OUTPUT SIGNAL TYPES AND MEASUREMENTS (Vr)

No.	Item		Symbol	Condition	Value			Unit
					Min.	Typ.	Max.	
1	V _S Setting	Voltage	V _r	Load 1kΩ	0	—	2.5	V
		Ripple/Noise	V _{NRR}	Load 1kΩ	—	—	±500	mV
		Stability (average)	—	Load 1kΩ	—	—	±0.1	%
		Current (average)	I _{CC}	Load 1kΩ	—	—	3	mA

NOTES:

1. V_r is set at a value obtained from the following formula which is relative to V_S

$$V_S = 170 + 10 \times V_r \text{ (V)}$$
 expression (1)
 (V_r: 0–2.5V)

Ex: V_S=180V → V_r=1.0V

INTERFACE SIGNAL

(1) Signal Definition and Function

Signal Name	Signal	Qty.	Signal Definition and Function
Data Signal (Digital RGB)	DATA-R	8	Display Data Signal: R7, G7 and B7 are the highest brightness data and R1, G1 and B1 are the lowest brightness data. Only the highest 8 bits of data are valid from 8 bits. (64 grayscale)
	DATA-G	8	
	DATA-B	8	
Clock	DCLK	1	Display Data Timing Signal Data is read in when DCLK is turned off. DCLK is continuously input.
Blanking signal	BLANK	1	When BLANKING signal is logical HIGH, data is valid and upper left justified. When BLANKING Signal is logical LOW, data is invalid (not read).
Horizontal Sync Signal	Hsync	1	Regulates one horizontal line of data. Begins control of the next line when Hsync is turned off.
Vertical sync Signal	Vsync	1	Screen Start up Control Timing Signal. Begins control of the next screen when Vsync is turned off.
Parity Signal	PARITY	1	For NTSC Image Display Data, this signal applies Even/Odd Field Setting. "H" Level: Odd Field "L" Level: Even Field
Display Enable Signal	DISPEN	1	Display/non-display Control Signal "H" Level: Display "L" Level: non-display
Brightness Control Signal	B-CNT (0) (1) (2)	3	Full Screen Display Brightness Setting Signal: Brightness is controlled continuously by the external resistance. (Variable Resistance: R=5.0kΩ connected to 3 input terminals (0, 1, 2))

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TABLE C4 - PDP Electrical Characteristics (Cont.)

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4. AUTHORS (Last name, first name, middle initial. If military, show rank, e.g. Doe, Maj. John E.) FORTIN, Roger		
5. DATE OF PUBLICATION (month and year) January 2002	6a. NO. OF PAGES 48	6b. NO. OF REFERENCES 7
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This technical memorandum describes in detail the development of a Topographical Map Display (ToMaDi). The ToMaDi display is an evaluation prototype, made from a 2 by 2 matrix of colour AC Plasma Display Panel (PDP) and designed to study alternatives to topographical paper maps for Command and Control (C&C) applications. Because ToMaDi is a computer display, it contributes to the digitization of the battlefield project. The brightness, the contrast ratio and the viewing angle are similar to that of a Cathode Ray Tube (CRT) display. But, contrarily to CRT, its shallow depth allows its usage in confined locations while maintaining a high portability. Despite the fact that their visual characteristics don't meet the quality of a paper topographical map, the results obtained are sufficiently positive to warrant both follow-up studies in advanced display systems and ToMaDi applications for the Department of National Defence.

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Plasma
AC Plasma
Video Interface
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Electronic Display
CRT

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